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Promises of Graphene Nanoelectronics

Chagaan Baatar, *Senior Member, IEEE*
Office of Naval Research
chagaan.baatar@navy.mil

Abstract- Graphene is a single atomic layer of carbon atoms arranged into a two-dimensional (2D) hexagonal lattice. Since its discovery in 2004 by physicists [1], single layer graphene has been produced by many different methods and sample quality has steadily improved [2]-[4]. Among the many fascinating properties of graphene that are of particular interest to nanoscale electronics are: (1). Strong ambipolar electric field effect: despite being a semi-metal with zero energy gap, graphene differs from conventional metals in that its charge carrier density can be continuously tuned from n-type (i.e. carriers are electrons) to p-type (i.e. carriers are holes) simply by applying an electric field; (2). Linear dispersion: in the vicinity of the charge-neutrality point (known as Dirac point), both electrons and holes obey linear energy-momentum dispersion relations (like photons), rather than the familiar quadratic form $\varepsilon = {p^2}/{2m}$. Indeed, at low temperature, the velocity of these particles is about 1/300th of the speed of light. (3). Ultra-high mobility: record mobilities for both electrons and holes, at room temperature, have been reported [5][6]; (4). Bandgap: while a large 2D graphene sheet has zero bandgap, a finite gap can be created in graphene by cutting the graphene sheet into narrow strips and the bandgap is expected to depend on both the strip width and its orientation[7]. (5). a bi-layer graphene has a voltage tunable bandgap that can be continuously tuned from zero to 0.3eV, which is in the MWIR range[8]. (6). rapid progress is being made in wafer-scale epitaxial growth of graphene via thermal sublimation of Si from SiC substrates[9]. (7). single molecule level sensitivity through charge sensing has been demonstrated[10]. In this presentation I will review some of the advances in graphene based nanoelectronics achieved under ONR sponsorship, and provide a snapshot of ONR's current investment in graphene based nanoelectronics.

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